

CLAIMS:

1. An electrosurgical generator connectable with a power input, comprising:
 - 5 an input treatment network responsive to said power input to provide a first output;
 - a frequency generator responsive to said first output and to a frequency control input to derive an output having a predetermined waveform;
 - 10 an output power control circuit responsive to a voltage level control input and a power level control input to derive an electrosurgical energy output at an electrosurgical voltage level and power level at said electrosurgical frequency;
 - 15 an output stage responsive to said output power control circuit electrosurgical energy output and connectable in electrical communication with an electrosurgical instrument; and
 - a control assembly responsive to a cut command to derive said voltage level control input to provide a boost electrosurgical voltage level for a boost interval and thereafter responsive to derive said power level control input in a tissue load resistance defined output voltage monitoring mode or an output power mode to effect a normal cut electrosurgical voltage level which is less than said boost electrosurgical voltage level.
- 20 2. The electrosurgical generator of claim 1 in which said boost electrosurgical voltage level is greater than said normal cut electrosurgical voltage level by about a 1.2 to about a 1.5 factor.
- 25 3. The electrosurgical generator of claim 1 in which said boost interval is about 100 to about 1000 milliseconds.
4. The electrosurgical generator of claim 1 in which said boost interval is about 250 to about 500 milliseconds.
- 30 5. The electrosurgical generator of claim 1 in which said control assembly derives said voltage level control input to provide a said boost electrosurgical voltage level of about 1000 volts, peak-to-peak, to about 2000 volts, peak-to-peak.
- 35 6. The electrosurgical generator of claim 1 in which said control assembly derives said voltage level control input to provide a said boost electrosurgical voltage level of about 1200 volts, peak-to-peak, to about 1500 volts, peak-to-peak.

7. The electrosurgical generator of claim 5 in which said control assembly derives said voltage level control input to provide a said normal cut electrosurgical voltage level of about 700 volts, peak-to-peak, to about 1200 volts, peak-to-peak.

5

8. The electrosurgical generator of claim 6 in which said control assembly derives said voltage level control input to provide a said normal cut electrosurgical voltage level of about 800 volts, peak-to-peak, to about 1000 volts, peak-to-peak.

10 9. The electrosurgical generator of claim 1 in which said input treatment network comprises:

a boost converter network responsive to a converter control input to derive said first output at an interim voltage level of first value; and

15 a converter control network responsive to said power input and to said interim voltage level to derive a said converter control input effective to provide power factor correction.

10. The electrosurgical generator of claim 1 in which:

20 said output voltage control circuit includes a relay switch responsive to a relay control input to terminate said electrosurgical energy output; and
said control assembly is responsive to a fault condition to derive said relay control input.

11. The electrosurgical generator of claim 10 comprising:

25 a high voltage monitor responsive to said electrosurgical energy output to derive a high voltage monitor signal; and
said control assembly is responsive to derive said relay control input when said high voltage monitor signal exceeds a high voltage threshold level.

30 12. The electrosurgical generator of claim 11 in which said control assembly is responsive in the presence of a said voltage level control input providing a boost electrosurgical voltage level to disable said relay control input.

35 13. The method for generating an electrosurgical cutting arc at an electrode confronting animal tissue comprising the steps of:

providing an input treatment network responsive to an applied source of electrical power to derive a first output;

providing a link inverter containing network responsive to said first output to derive a link voltage of controllable amplitude;

5 providing an R.F. inverter network responsive to said link voltage to generate an R.F. output of predetermined electrosurgical cutting frequency and exhibiting an inverter voltage level corresponding with said link voltage controllable amplitude;

stepping up said inverter voltage level to derive an electrosurgical cutting output at an electrosurgical cutting power level;

10 10 commencing the application of said electrosurgical output to said electrode and continuing said application thereafter;

monitoring the voltage level of said electrosurgical output to provide an output voltage monitor signal;

monitoring the power level of said electrosurgical output to provide an 15 output power monitor signal;

comparing said output voltage monitor signal with a reference representing a target value of said voltage level to derive a voltage mode program control signal;

comparing said output power monitor signal with a reference representing 20 a target value of output power level to derive a power mode program control signal; and

controlling said link inverter containing network by applying either said voltage mode program control signal or said power mode program control signal thereto;

14. The method of claim 13 in which:

25 said step of monitoring said voltage level of said electrosurgical output monitors said electrosurgical cutting voltage level to provide said output voltage monitor signal as a high voltage monitor signal;

said step of comparing said monitor signal with a reference carries out said comparison employing a predetermined electrosurgical cutting voltage level as said 30 target value; and

said step of controlling said link inverter containing network is carried out by applying said program control signal thereto at a slow rate effective to avoid oscillation of said electrosurgical cutting output.

35 15. The method of claim 14 in which said step for controlling said link inverter applies said program control signal under low bandwidth conditions.

16. The method of claim 14 including the steps of:
 - monitoring said d.c. link voltage amplitude to provide a link voltage controlling feedback signal; and
- 5 further controlling said link inverter containing network by applying said feedback signal to said link inverter containing network at a rate faster than said slow rate.
- 10 17. The method of claim 16 in which said step for further controlling said link inverter containing network applies said feedback signal at a high gain.
- 15 18. The method of claim 13 in which said step of controlling said link inverter containing network applies a said program control signal when commencing said application of said electrosurgical output in a manner effecting derivation of said link voltage at a boost level for a boost interval effective to cause generation of a said electrosurgical cutting arc when said electrode is in contact with said tissue.
- 20 19. The method of claim 18 in which said step of controlling said link inverter containing network provides said boost level for a fixed said boost interval.
- 25 20. The method of claim 19 in which said fixed boost interval is about 0.5 second.
21. The method of claim 19 in which said fixed boost interval is about three eighths second.
- 30 22. The method of claim 18 in which said step of controlling said link inverter containing network applies said program control signal to derive said link voltage at a said boost level for said boost interval and thereafter applies said program control signal to derive said link voltage at a cut level less than said boost level and effective to sustain the formation of an arc at said electrode.
- 35 23. The method of claim 22 in which said cut level corresponds with a power value of said application of said electrosurgical output which is about one-half the power value of said electrosurgical output when at said boost level.

24. The method of claim 13 in which:

said step of monitoring said select electrical parameter monitors said electrosurgical cutting voltage level and the electrosurgical current corresponding therewith to provide said output monitor signal as a power monitor signal;

5 said step of comparing said monitor signal with a reference carries out said comparison employing a predetermined value of power as said target value; and

said step of controlling said link inverter containing network is carried out by applying said program control signal thereto.

10 25. The method of claim 24 in which said step of controlling said link inverter containing network applies a said program control signal when commencing said application of said electrosurgical output in a manner effecting derivation of said link voltage at a boost level for a boost interval effective to cause generation of a said electrosurgical cutting arc when said electrode is in contact with said tissue.

15

26. The method of claim 25 in which said step of controlling said link inverter containing network provides said boost level for a fixed said boost interval.

20

27. The method of claim 26 in which said fixed boost interval is about 0.5 second.

28. The method of claim 26 in which said fixed boost interval is about three eighths second.

25

29. The method of claim 25 in which said step of controlling said link inverter containing network applies said program control signal to derive said link voltage at a said boost level for said boost interval and thereafter applies said program control signal to derive said link voltage at a cut level less than said boost level and effective to sustain the formation of an arc at said electrode.

30

30. The method of claim 29 in which said cut level corresponds with a power value of said application of said electrosurgical output which is about one-half the power value of said electrosurgical output when at said boost level.

31. The method of claim 13 in which said step of providing an input treatment network provides a power factor correction with respect to said applied source of electrical power and derives said first output as a regulated d.c. voltage.

5 32. The method of claim 13 in which said step of providing a link inverter containing network provides said link inverter containing network as including an inverter control network effecting a resonant transition phase shift control of said link inverter and further including a rectifier for providing said link voltage as a d.c. link voltage.

10 33. The method for generating an electrosurgical cutting arc at an electrode configured for cutting tissue, exhibiting a range from human tissue resistances comprising the steps of:

providing an input treatment network responsive to an applied source of electrical power to derive a first output;

15 providing a frequency generator containing network responsive to said first output and to a control input to derive a second output having a tissue cutting waveform;

20 providing an output stage responsive to said second output and connectable in electrical communication with said electrode for applying electrosurgical energy thereto at a first level of voltage effective to create said arc and subsequently at a second level of voltage less than said first level of voltage effective to sustain said created arc; and

25 controlling said frequency generator containing network to derive said first level of voltage at the commencement of said application of said electrosurgical energy to said electrode for a boost interval effective to create said cutting arc, and thereafter to derive said second level of voltage effective to generate said electrosurgical cutting arc at a substantially constant power across said range of human tissue resistances.

30 34. The method of claim 33 in which said step of controlling said frequency generator containing network provides said first voltage level as being greater than said second voltage level by about a 1.2 to about 1.5 factor.

35 35. The method of claim 33 in which said step of controlling said frequency generator containing network provides a fixed said boost interval of about 0.5 seconds.

36. The method of claim 33 in which said step of controlling said frequency generator containing network provides a fixed said boost interval of about three eighths second.

5 37. The method of claim 33 in which said step of controlling said frequency generator containing network provides said first level as voltage between about 1000 volts, peak-to-peak, and about 2000 volts, peak-to-peak.

10 38. The method of claim 33 in which said step of controlling said frequency generator containing network provides said first level as voltage between about 1200 volts, peak-to-peak and about 1500 volts peak-to-peak.

15 39. The method of claim 37 in which said step of controlling said frequency generator containing network provides said second level of voltage between about 700 volts, peak-to-peak and about 1200 volts, peak-to-peak.

40. The method of claim 37 in which said step of controlling said frequency generator containing network provides said second level of voltage between about 800 volts, peak-to-peak and about 1000 volts, peak-to-peak.

20 41. An electrosurgical generator, connectible with a power input, comprising:
an input treatment network responsive to said power input to derive an interim voltage output of first value;
a first inverter network responsive to said interim voltage and to a first inverter control input to derive a first alternating voltage output of second value less than said first value at a first inverter output;
a first inverter control network coupled with said first inverter network and deriving said first inverter control input;
a rectifier network responsive to said first alternating voltage output to derive a link output at a d.c. voltage level corresponding with said first alternating voltage output second value;
a second inverter network having an input, and responsive to said link output to derive a second alternating voltage output at an electrosurgical frequency value and with voltage amplitudes established by said link output d.c. voltage level;

a second inverter control network coupled with said second inverter network to effect derivation of said second alternating voltage output electrosurgical frequency;

5 a high voltage transformer having a primary side responsive to said second alternating voltage output and a secondary side deriving an electrical cutting energy input at an electrosurgical voltage level and at said electrosurgical frequency;

an output stage coupled with said high voltage transformer secondary side and connectable in electrical communication with an electrosurgical instrument;

10 a high voltage monitor responsive to said electrical cutting energy input to derive a high voltage monitor signal;

a high voltage current monitor responsive to said electrical cutting energy input to derive a high voltage current monitor signal;

said first inverter control network includes:

15 a power derivation network responsive to said high voltage monitor signal and said high voltage current monitor signal to derive a monitored power signal;

a first comparator network responsive to a power reference and to said monitored power signal to derive a lower load resistance defined first program signal;

20 a second comparator network responsive to a voltage reference and to said high voltage monitor signal to derive a higher load resistance defined second program signal; and

a controller network responsive to said first or second program signal of load resistance defined to derive said first inverter control input.

42. The electrosurgical generator of claim 41 in which said first inverter control network derives said first inverter control input to effect a resonant transition phase shift control of said first inverter.

43. The electrosurgical generator of claim 41 in which said first inverter control network comprises:

30 a power monitoring circuit responsive to said electrical cutting energy input to derive a program signal; and

a controller network responsive to said program signal to derive said first inverter control input.

35 44. The electrosurgical generator of claim 41 in which said power derivation network comprises:

a multiplier circuit responsive to said high voltage monitor signal and to said high voltage current monitor signal to derive a product output; and

an integrator network responsive to said product output to derive said monitored power signal.

5

45. The electrosurgical generator of claim 41 comprising:

a control assembly actuatable to derive a boost voltage signal for a boost interval; and

10 said first inverter control network is responsive to said boost voltage signal to derive a said first inverter control input effecting derivation of said first alternating voltage output second value at a boost voltage value, and is responsive thereafter to derive said first inverter control input effecting derivation of said first alternating voltage output second value at a normal cut voltage value less than said boost voltage value.

15

46. The electrosurgical generator of claim 45 in which said boost voltage valve is greater than said normal cut voltage value by a factor within a range from about 1.2 to about 1.5.

20

47. The electrosurgical generator of claim 41 including an isolation transformer having a primary side coupled with said first alternating output and a secondary side providing said first alternating voltage output to said rectifier network.

25

48. The electrosurgical generator of claim 41 in which said second inverter network comprises a resonant tank circuit.

49. The electrosurgical generator of claim 46 in which said boost interval is about 100 to about 1000 milliseconds.

30

50. The electrosurgical generator of claim 46 in which said boost interval is about 250 to 750 milliseconds.

35

51. The electrosurgical generator of claim 46 in which said boost voltage value effects derivation of a said electrosurgical voltage level of about 1000 volts peak-to-peak to about 2000 volts peak-to-peak.

52. The electrosurgical generator of claim 46 in which in which said boost voltage value effects derivation of a said electrosurgical level of about 1200 volts, peak-to-peak to about 1500 volts, peak-to-peak.

5 53. The electrosurgical generator of claim 51 in which said normal cut voltage value effects derivation of said electrosurgical cutting voltage level of about 700 volts, peak-to-peak to about 1200 volts, peak-to-peak.

10 54. The electrosurgical generator of claim 52 in which said normal cut voltage value effects derivation of said electrosurgical cutting voltage level of about 800 volts, peak-to-peak to about 1000 volts, peak-to-peak.

55. The electrosurgical generator of claim 41 in which said input treatment network comprises:

15 a boost converter network responsive to a converter control input to derive said interim voltage of first value; and

a converter control network responsive to said power input and to said interim voltage first value to derive a said converter control input effective to provide power factor correction.

20 56. The electrosurgical generator of claim 41 comprising:

a relay switch connected between said rectifier network and said second inverter network input and responsive to a relay control input to convey or terminate conveyance of said link output to said second inverter network; and

25 a control assembly responsive to a fault condition to derive a said relay control input terminating conveyance of said link output to said second inverter network input.

30 57. The electrosurgical generator of claim 56 in which:

said first inverter control network comprises a power monitoring circuit responsive to said electrical cutting energy input to derive a power signal corresponding with the level of power exhibited by said electrical cutting energy input; and

35 said control assembly is responsive to derive a said relay control input terminating said conveyance of said link output when said power signal exceeds a power threshold level.

58. The electrosurgical generator of claim 56 comprising:
 - a high voltage monitor responsive to said electrical cutting energy input to derive a high voltage monitor signal; and
 - 5 said control assembly is responsive to derive a said relay control input terminating said conveyance of said link output when said high voltage monitor signal exceeds a high voltage threshold level.
59. The electrosurgical generator of claim 56 comprising:
 - 10 a high voltage current monitor responsive to said electrical cutting energy input to derive a high voltage current monitor signal; and
 - 15 said control assembly is responsive to derive a said relay control input terminating said conveyance of said link output when said high voltage current monitor signal exceeds a current threshold level.
- 15 60. The electrosurgical generator of claim 56 comprising:
 - 20 a link voltage monitor responsive to said rectifier network link output to derive a link monitor signal corresponding with said link output d.c. voltage level; and
 - 25 said control assembly is responsive to derive a said relay control input terminating said conveyance of said link output when said link monitor signal corresponds with a said link output d.c. voltage level which exceeds a link over-voltage threshold level.
- 25 61. The electrosurgical generator of claim 60 in which said control assembly is responsive to derive said relay control input terminating said conveyance of said link output when said link monitor signal corresponds with a said link output d.c. voltage level which is below a predetermined under-voltage threshold level.
- 30 62. The system of claim 41 comprising:
 - 35 derive a high voltage monitor signal; and
 - 35 said first inverter control network comprises:
 - 40 a comparator network responsive to a predetermined electrosurgical cutting voltage level and to said high voltage monitor signal to derive a program signal; and
 - 45 a controller network responsive to said program signal to derive said first inverter control input.

63. The system of claim 62 in which said controller network is configured to derive said first inverter control input as a slowly applied said program signal.

5 64. The system of claim 63 in which said first inverter control network comprises:

a link voltage monitor responsive to said link output to provide a link voltage controlling feedback signal; and

10 said controller network is further responsive to said link voltage controlling feedback signal to derive said first inverter control input.